# Evaluating CLM3-Simulated Vegetation Phenology with Satellite and Ground-based Observations

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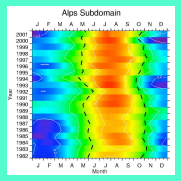
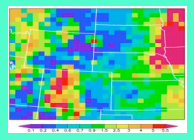
## 1. Hypothesis

♣**Strong seasonal and interannual variabililties of leaf area index (LAI) and its vegetation-dependent spatial heteorogeneity are observed.**



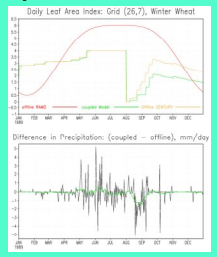

Interannual and seasonal variability as observed in the 20-year period from 1982 to 2001 for Alps sub-domain. The black dashed line show the area-averaged start and end of the growing season. (Stockli and Vidale, 2004)

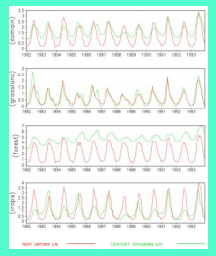


Derived LAI spatial distribution for Central U.S. for average year 1989. (Lu and Shuttleworth, 2002)

♣**Including realistic description of heteorogeneous vegetation phenology influences the seasonal climate prediction.**


LAI response of CENTURY is different after harvest when run in coupled mode. The coupled model gives a response in modeled precipitation. (Lu et al, 2001)




♣**Prognostic simulation of land-atmosphere interaction with respect to climate variability and change requires realistic representation of changing distributions of transpiring leaves in response to diurnal, seasonal, interannual, and longer-term changes in weather and climate.**

## 2. Objectives

♣**Evaluate and improve the multi-scale vegetation modeling system (CLM based) for simulating land-atmosphere exchanges of water, energy, and carbon that includes global prediction of leaf area index, through simulating vegetation geographic distribution and biogeochemical cycle.**

♣**Include options for simple climate-based prognostic phenology and for more dynamic phenology based on biogeochemical cycling, and the allocation of nutrients and the fate of organic matter.**

♣**Apply in both a prognostic climate model (Community Climate System Model, CCSM), and in a global operational diagnostic (data assimilation) model (Land Information System).**

## 3. Technical Approach and Methods

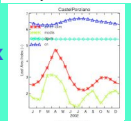
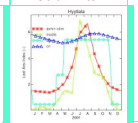
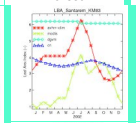
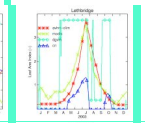
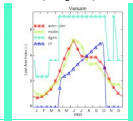
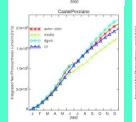
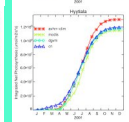
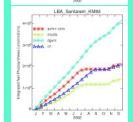
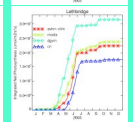
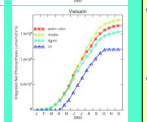
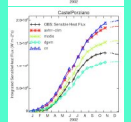
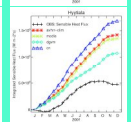
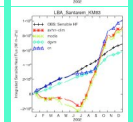
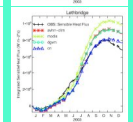
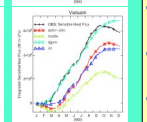
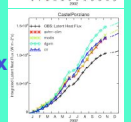
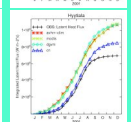
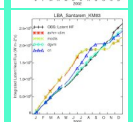
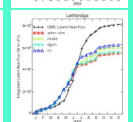
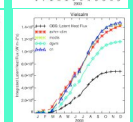
**Based on Community Land Model (CLM3, Zeng et al, 2002; Dai et al, 2003; Bonan et al, 2003; Levis et al, 2004; Levis and Bonan, 2004), Biome-BGC (Running and Hunt, 1993; Thornton 1998; White et al, 2000), and the Simple Biosphere Model (SiB, Seller et al, 1996; Baker et al, 2003; Vidale and Stockli, 2005), and estimate global phenology parameters using EKF approach, to form CLM-DGVM-CN.**

## 4. Data Sets Needed

**MODIS NDVI-derived products for model initialization, parameterization, and evaluation.**
**Evaluation will first focus on process scales and aggregating to increasingly large area.**

1. Testing the predictions of vegetation phenology against local observations:
   - IPG: observed phenology in phenological gardens (20 sites, 47 year long dataset, Europe only);
   - US-NPN (National Phenology Network, US only).
2. Understanding the sensitivity of modeled land surface heat, water, and carbon fluxes to prognostic vegetation phenology at local scales:
   - FLUXNET: global 400 flux towers, 1995-present, eddy covariance water, energy, momentum, and carbon fluxes, soil temperature, and moisture profiles, micrometeorological observations (Baldocchi et al, 2001)
   - Evaluate physiological stress representation, seasonal drought in Oregon and Oklahoma; interanual changes in dry-season duration and severity at Tapajos sites
3. Evaluation of biogeochemical cycling against local measurements of biogeochemical fluxes and pool sizes in well-studied ecosystems:
   LTER: ground observed vegetation states (26 sites, 20 year long dataset, USA only, http://www.lternet.edu/ )

## 5. Very First Simulations with CLM3-DGVM and CLM3-CN

| Site Description | Castelporziano (41.71N, 12.38E) Mediterranean (Italy) Evergreen Broadleaf Dry summer | Hyytiala (61.85N, 41.17E) Boreal Needleleaf Forest (Finland) Cold winter | Santarem KM83 (3.02S, 54.97W) Evergreen Broadleaf Forest | Lethbridge (49.71N, 112.94W) Grasslands, mixed Prairie (Canada) | Vielsalm (50.30N, 6.0E) Temperate Broadleaf Deciduous Forest (Belgium) |
|---|---|---|---|---|---|
| Leaf Area Index (LAI) |  |  |  |  |  |
| GEP (umol/m2) |  |  |  |  |  |
| Sensible Heat Flux (J/m2) |  |  |  |  |  |
| Latent Heat Flux (J/m2) |  |  |  |  |  |

**Model Specs:**

- CLM3 with new hydrology;
- Parameters are not tuned;
- PFT and soil types are prescribed for CN, but not for DGVM;
- Spin-up for CN and DGVM > 200 yrs;
- Modis: 16-day, 10-km, individual years 2000-2005;
- AVHRR-clim: 16-day, 10-km, 1982-2001 climatology;
- CN: prognostic LAI from allocation approach;
- DGVM: prognostic LAI from GDD/NPP approach.

## 6. References

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